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VISCOSITY MEASUREMENTS OF ASBESTOS TAILINGS MIXTURES

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VISCOSITY MEASUREMENTS OF ASBESTOS TAILINGS MIXTURES

by

S.S.B. Wang

SUMMARY

Viscosity measurements were obtained as a function of temperature for four asbestos tailings-slag mixtures. Results indicate that, once completely molten, these samples have viscosities in the range of 35-50 x 10^{-3} Pa.s which remain fairly constant even with further increase in temperature. A sample containing 15% Na_2CO_3 encountered boiling problems. This probably was caused by the decomposition of Na_2O at 1400-1600°C. This boiling phenomenon also renders the viscosity data for this sample much less reliable.

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INTRODUCTION

A. Duval and Associés requested that CANMET measure the viscosities of four asbestos tailings-steel making slag mixtures, by CANMET's high temperature viscometer. This is in connection with work being carried out by the research centre of La Société Nationale de l'Amiante (SNA) in further development of a process for the production of mineral wool from asbestos tailings developed by CANMET. The work was carried out on a full cost recovery arrangement. SNA supplied the sample materials and chemical analyses.

EXPERIMENTAL WORK

SAMPLE

The chemical compositions of the asbestos tailings, sand, and slags are shown in Table 1. The mix proportioning of the four samples for viscosity measurements is given in Table 2.

Table 1 - Chemical compositions of sample materials

Sample Materials	SiO_2	MgO	CaO	Al_2O_3	Fe_2O_3	Na_2O	K_2O	MnO
Asbestos tailings	46.20	42.64	0.41	1.14	8.80	0.26	0.17	n.d.
Slag "C"	18.19	8.44	28.84	5.14	38.80	n.d.	n.d.	2.38
Slag "DOSCO"	18.04	11.77	36.64	6.56	24.02	n.d.	n.d.	3.06
Sand	78.72	1.01	1.17	10.00	3.25	2.20	2.39	n.d.

n.d. - not determined

Table 2 - Mix proportions of the samples for viscosity measurements, wt%

Sample identification	Calcined asbestos tailings	Sand	Slag "C"	Slag "DOSCO"	Pure Na_2CO_3
L6	50	-	50	-	-
L7	60	-	40	-	-
L8	57.5	17.5	25	-	-
L13	60*	-	-	25	15

*Asbestos tailings in sample L13 were not calcined before mixing.

About 130 to 140 g of sample was required and each sample was calcined at 1000°C before viscosity measurements.

VISCOMETER

The high temperature viscometer system is shown schematically in Fig. 1. It consists of (a) an induction furnace (b) a viscometer incorporating a variable speed Brookfield torque meter with a molybdenum crucible and bob, and (c) a gas train. Details of the apparatus construction are given elsewhere (1).

Induction heating is used to melt the sample by coupling an induction generator to the molybdenum crucible. The heat loss from the furnace is minimized by placing the molybdenum crucible inside an alundum crucible, the gap between the two crucibles being filled with alumina beads as additional insulation. In addition, an alundum tube lined with platinum foil is used as a heat shield, and a platinum heat reflector plate is placed on top of the alundum tube. The whole assembly is set inside a silica tube which, in turn, is snuggly fitted inside the induction coil.

The torque meter is a Brookfield Rheolog type viscosity transmitter, Model RVG, equipped with an 8-speed transmission. The Rheolog sensing head (transmitter) output is fed into a pneumatic-to-electric transducer giving an output of 0-10 mv which, in turn, is fed to a recorder. The viscometer system was calibrated using standard silicone oils. The signal from the transmitter was recorded in terms of millivolts for a given bob rotation speed for each standard viscosity fluid.

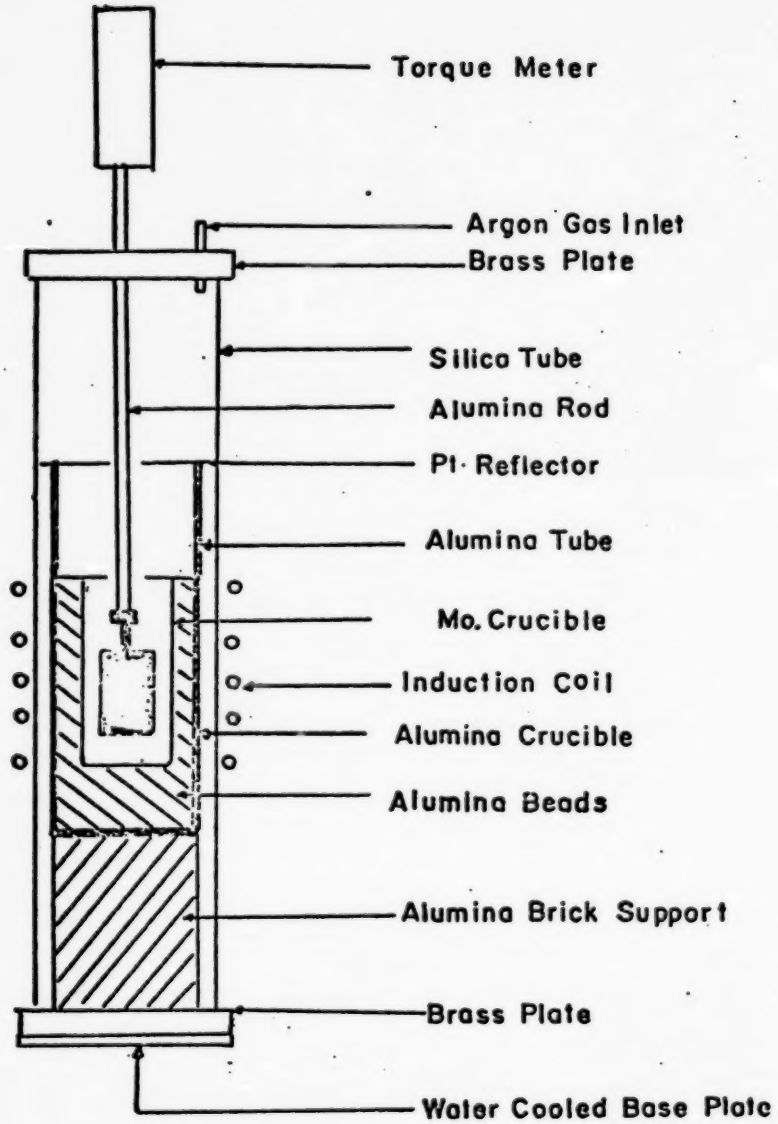

Fig. 1 - Schematic diagram of the viscometer set-up

The viscosity measurements were carried out under a positive pressure of argon mixed with 1% nitrogen. The nitrogen served to eliminate the ionization (arcing) of the argon gas at high temperature.

VISCOSITY MEASUREMENT

After the sample-filled molybdenum crucible had been properly positioned in the induction furnace, the system was flushed with argon gas for about 10 min. The furnace temperature was then raised to the desired minimum for the viscosity measurement. Once the furance had reached thermal equilibrium, the bob was lowered into position in the melt and the torque meter motor started. Readings were recorded continuously as the furnace temperature was increased to a maximum of 1600°C. The melt was then cooled and viscosity readings taken until a solid or crust appeared on the melt. If necessary, the heating and cooling cycle could be repeated.

RESULTS AND DISCUSSION

The viscosity data are presented graphically as a function of temperature in Fig. 2.

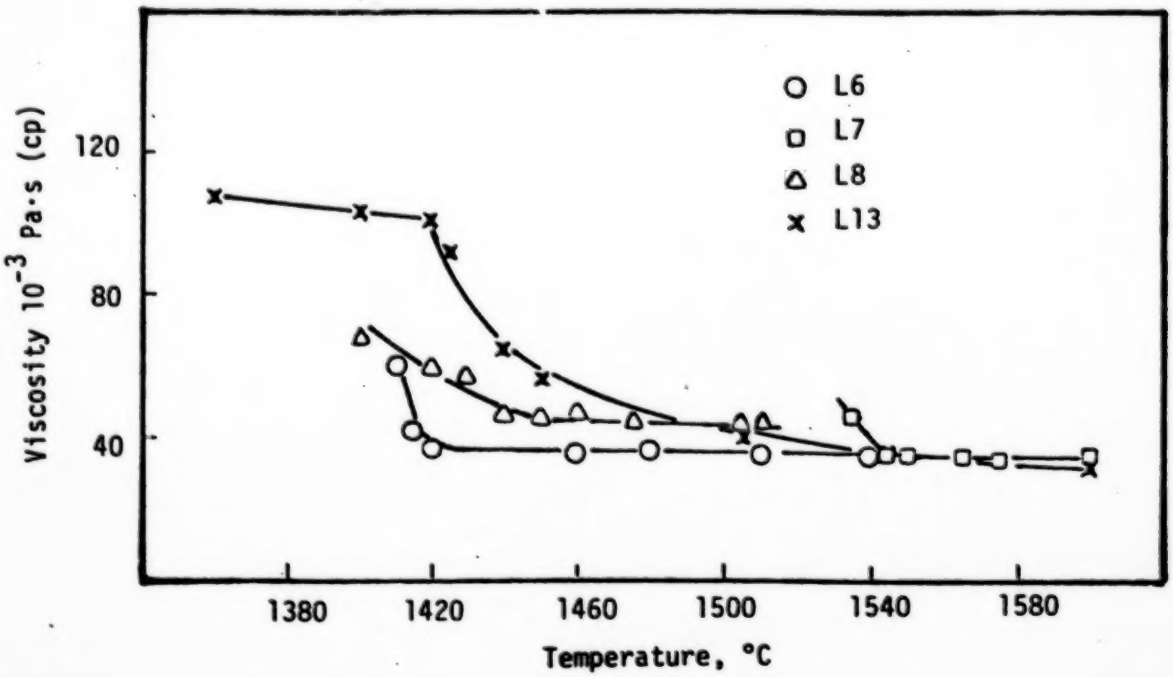

Fig. 2 - Viscosity as a function of temperature

The results for samples L6, L7 and L8 show that the temperature effect on viscosity is minimal once the samples have completely melted. The viscosity curves become quite flat in Fig. 2 and the viscosity values are low in the range of 35 to 50 x 10^{-3} Pa.s (35 to 50 centipoise). A characteristic rapid increase in viscosity of samples L6 and L7 on cooling was noted at a specific temperature, which probably coincides with their temperature of crystallization. In sample L8, the addition of 17.5% sand, which contains 78.72% SiO_2 and 10% Al_2O_3, apparently made the melt more glassy. Consequently, the increase of its viscosity on cooling to its melting point is not as sharp as in the case of samples L6 and L7, and the viscosities for sample L8 are generally higher than those for samples L6 and L7. The viscosity curve of sample L13 appears to consist of two branches, one between 1360-1420°C, the other between 1420-1600°C. It was observed that appreciable boiling occurred on the surface of the melt at 1440°C and, at 1550°C, the boiling became violent. This sample contained 15% Na_2CO_3 which starts to dissociate into Na_2O and CO_2 at 840°C (2). Vapour-pressure data indicate that Na_2O decomposes appreciably in the 1400-1600°C temperature range, mainly to the gaseous elements (3). This Na_2O decomposition probably caused the boiling and the sudden change of viscosity at 1420°C. The violent nature of the boiling in this melt makes the viscosity values for sample L13 much less reliable.

REFERENCES

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